

**ECTQG 2013**, September 5-9, 2013  
Dourdan, France

## **Exploring future urban sprawl with the Ocelet Language**

### **A spatial simulation model developed with planners and researchers in Reunion Island**

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UMR ESPACE-DEV / IRD - University of La Réunion  
UMR TETIS / CIRAD





Context?

**The DESCARTES project**



# The DESCARTES Project

- ✦ **ANR** (French National Research Agency)
- ✦ 2012-2014
- ✦ 3 institutions:
  - ✦ **IRD**
  - ✦ **CIRAD**
  - ✦ **University of La Réunion**
- ✦ 4 labs:
  - ✦ UMR **Espace-Dev**
  - ✦ UMR **Tetis**
  - ✦ UPR **Sca**
  - ✦ UMR **Selmet**

**Spatial simulation models**



experimentation territory

**Reflect on land-use scenarios / Improve collective learning**



# Reunion Island



- ✦ French Island
- ✦ Indian Ocean
- ✦ 2,500 km<sup>2</sup>
- ✦ 800,000 people
- ✦ 3000 m high

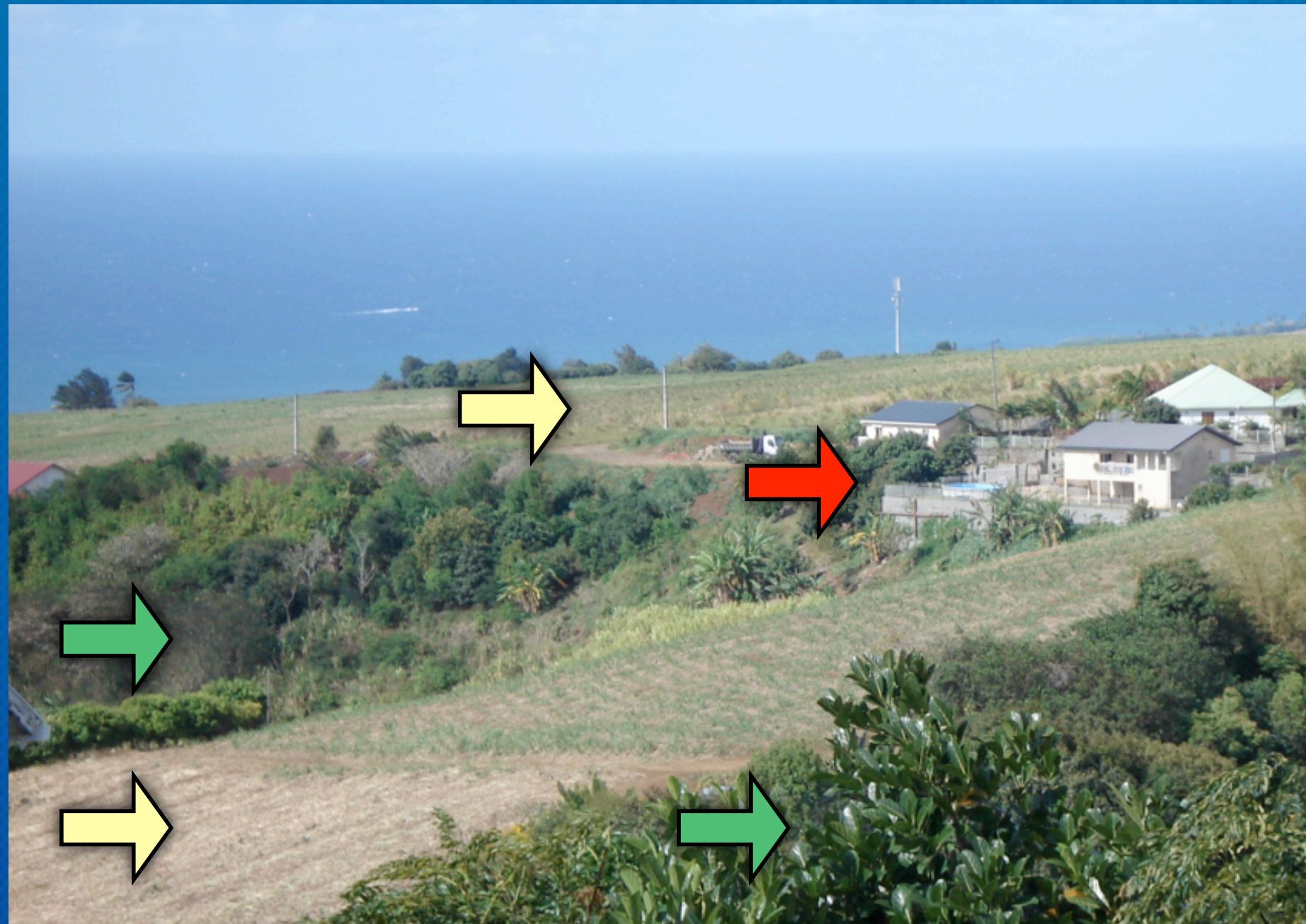


# Huge variety of landscapes





# Huge variety of landscapes



- ✦ **Agricultural**  
spaces

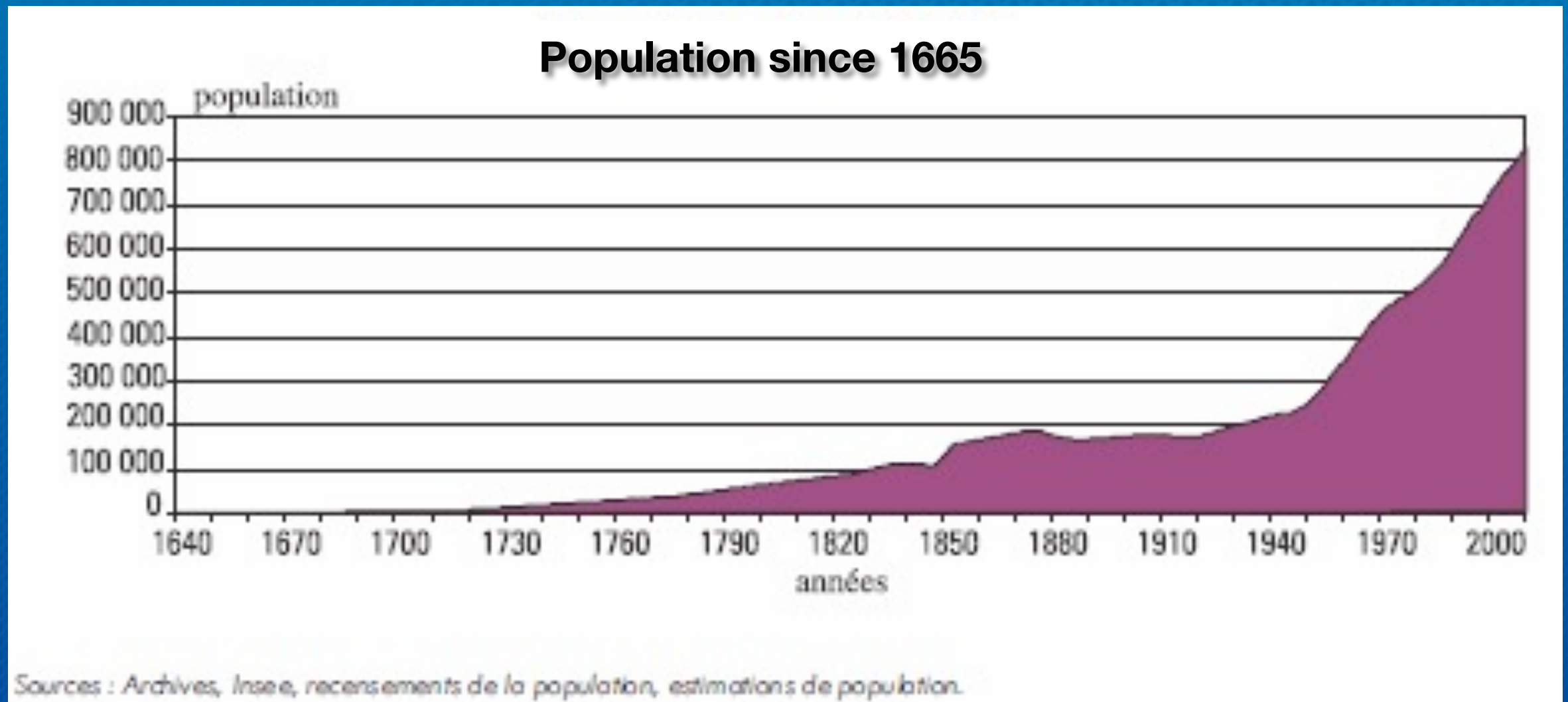
- ✦ **Natural**  
space

- ✦ **Urban**  
spaces

➔ **Explore urbanization processes in Reunion**



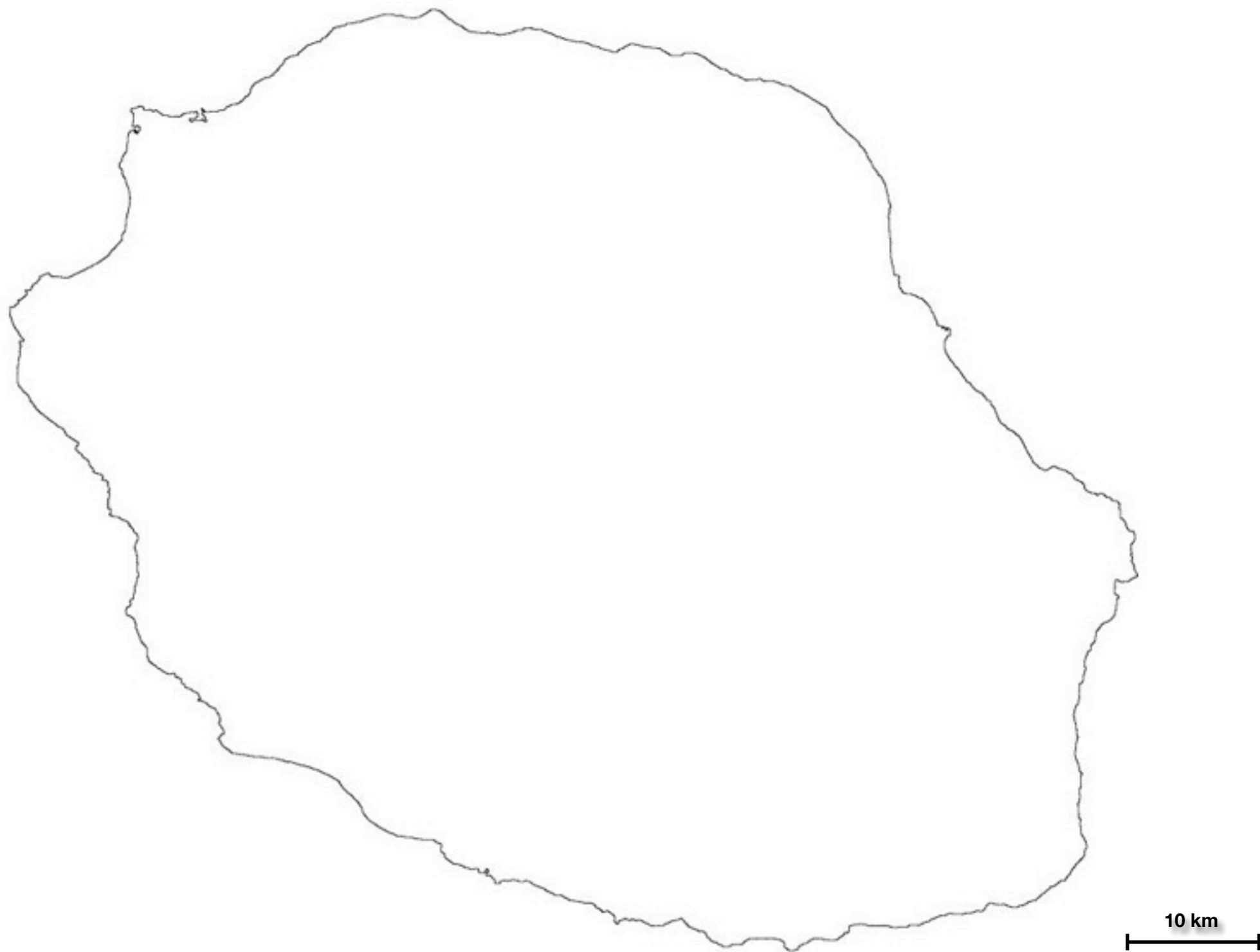
# Demographic evolution



- ✦ Projections: **1,000,000** inhabitants in **2030**
- ✦ **+ 20% !!!**

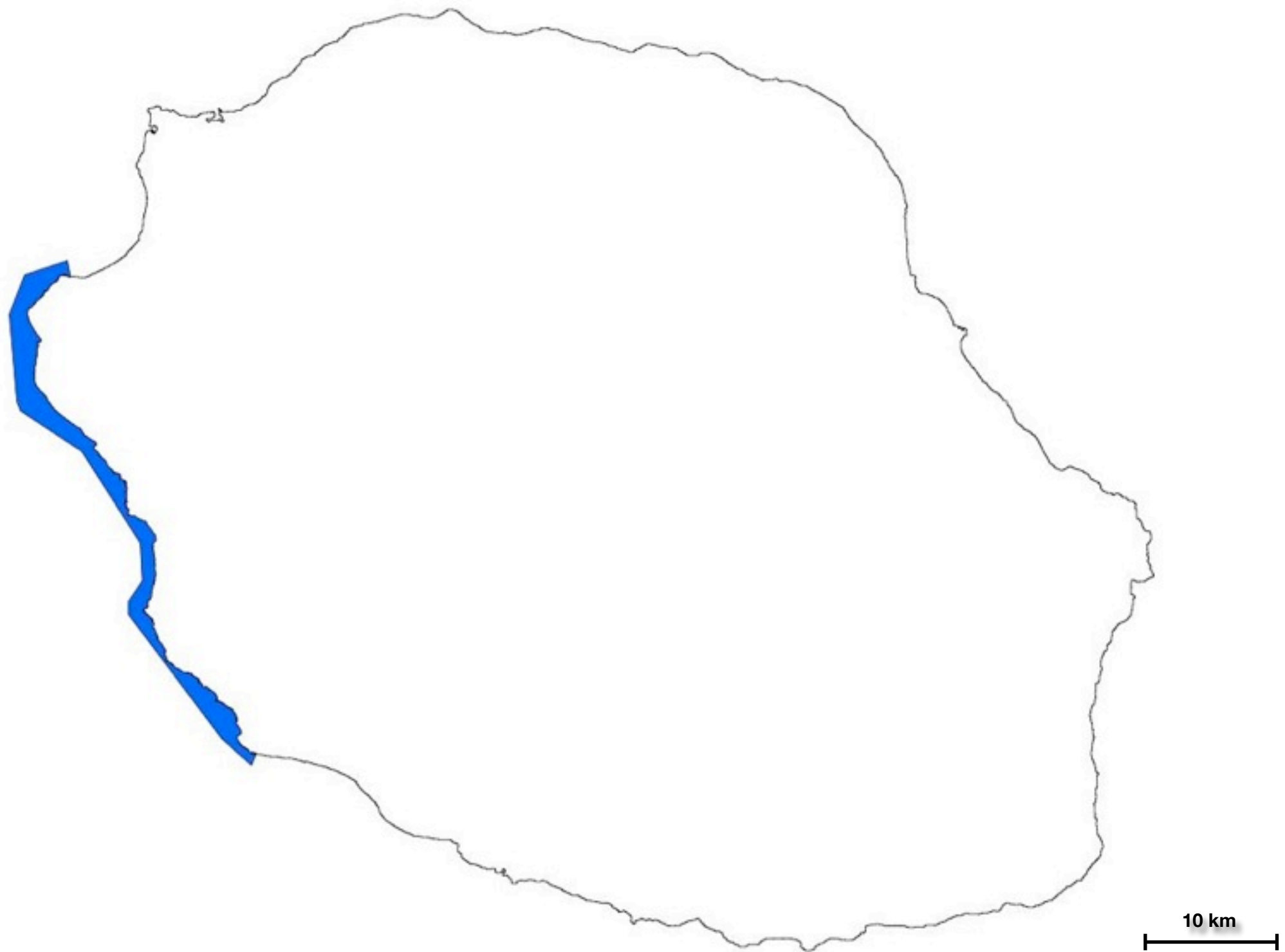


# Reunion Island



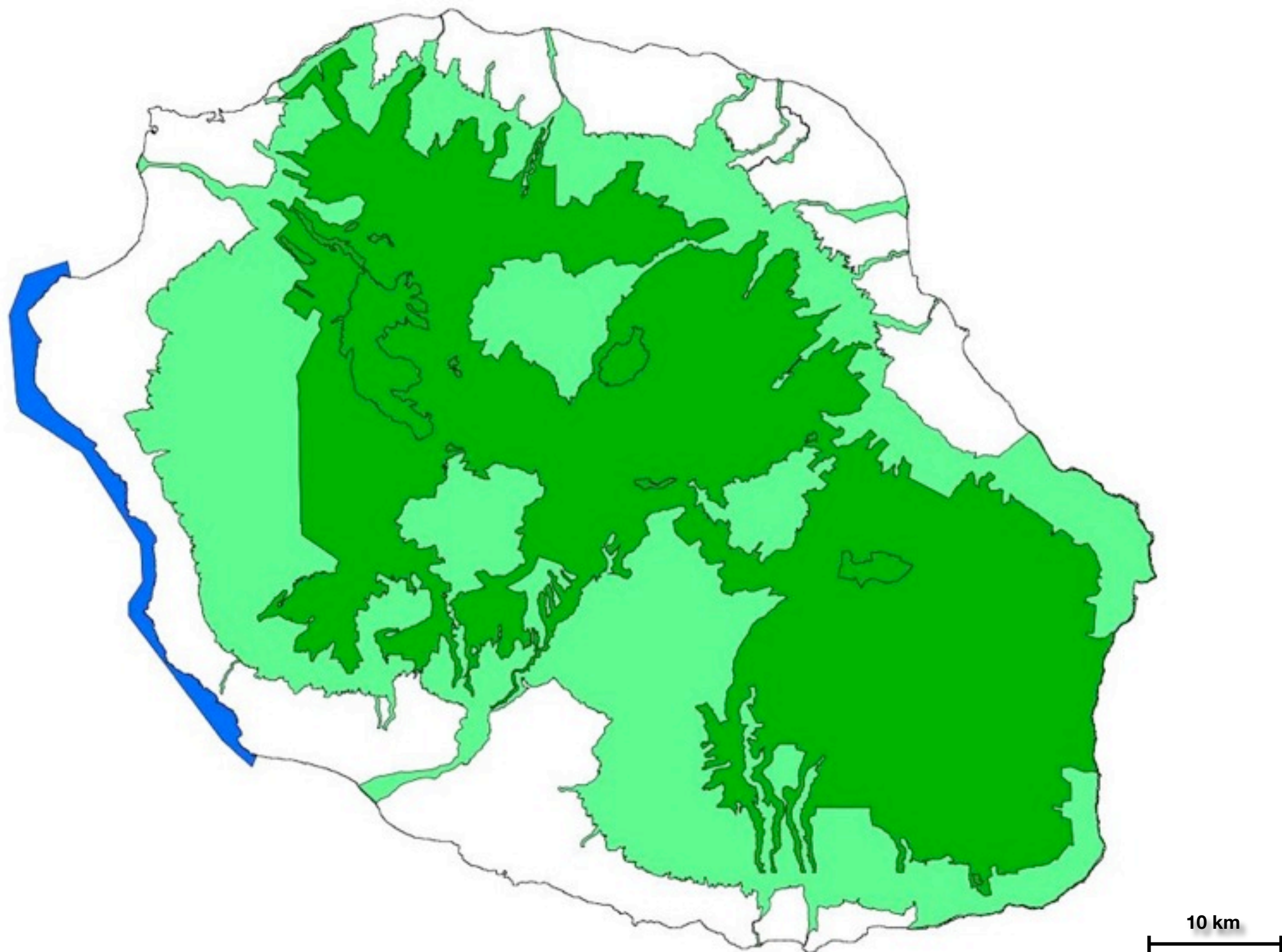


# Reunion Island - Marine Reserve



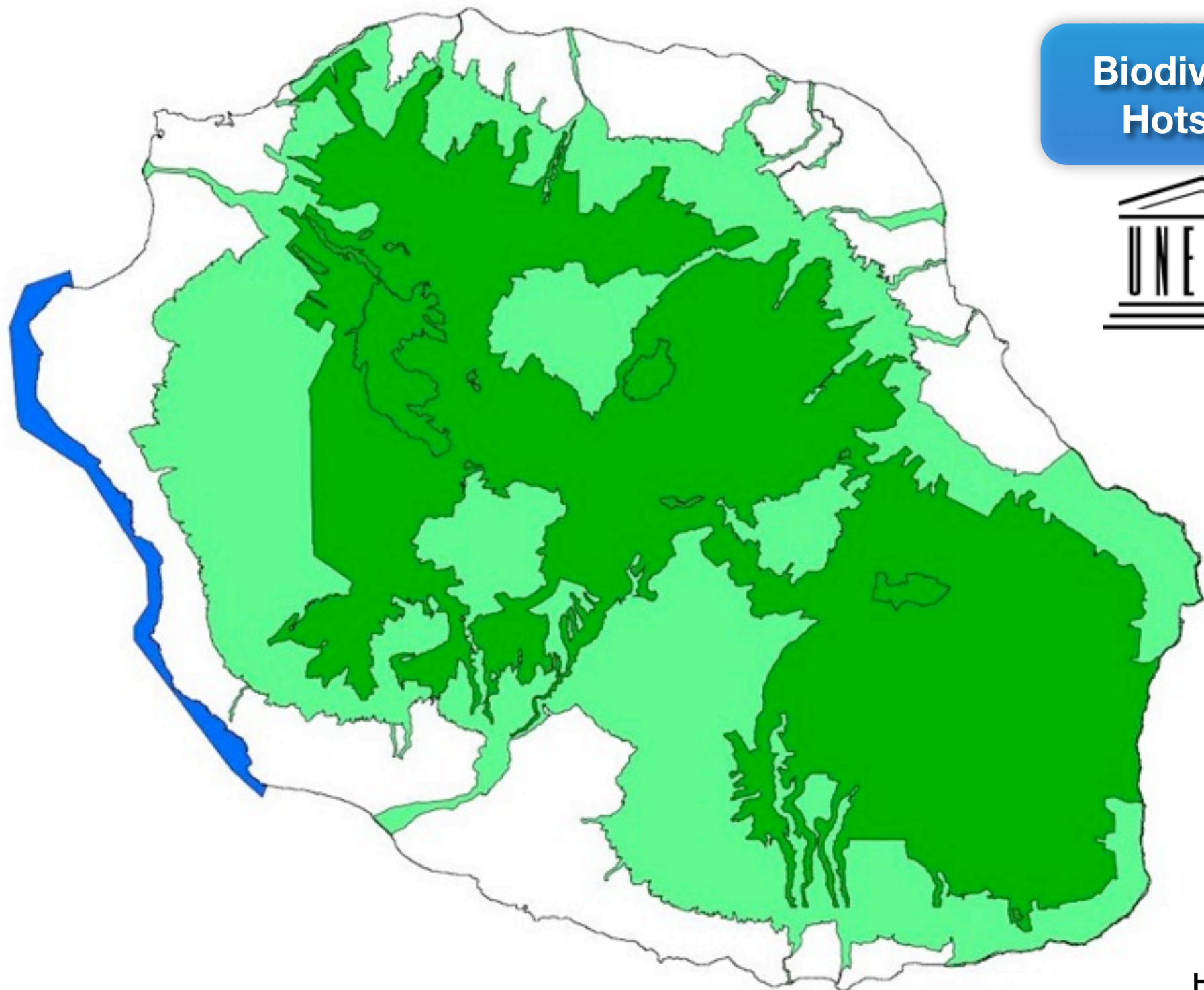


# Reunion Island - Marine Reserve - National Park





# Reunion Island - Marine Reserve - National Park

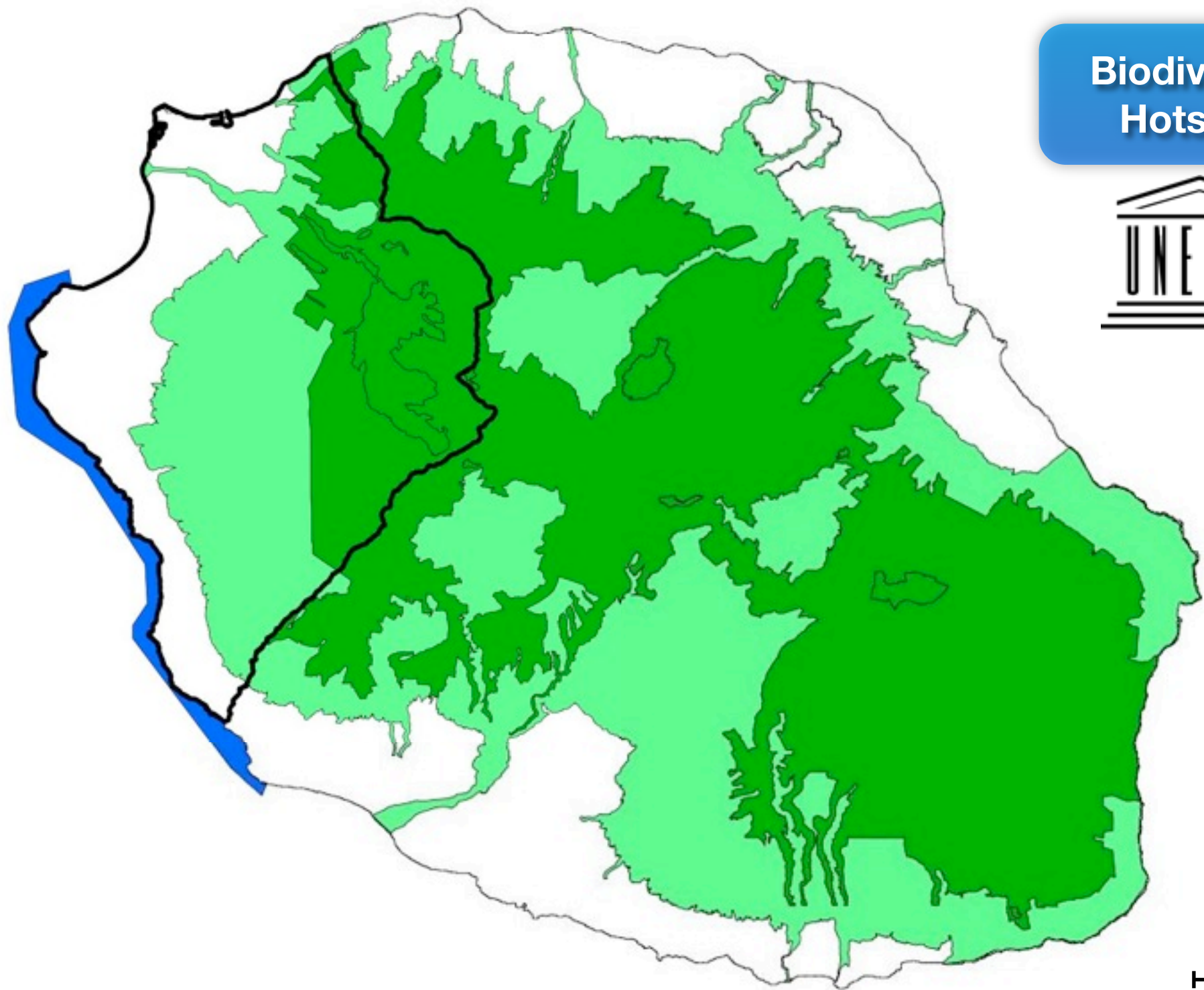


**Biodiversity  
Hotspot!**





# Reunion Island - TCO territory



**Biodiversity  
Hotspot!**

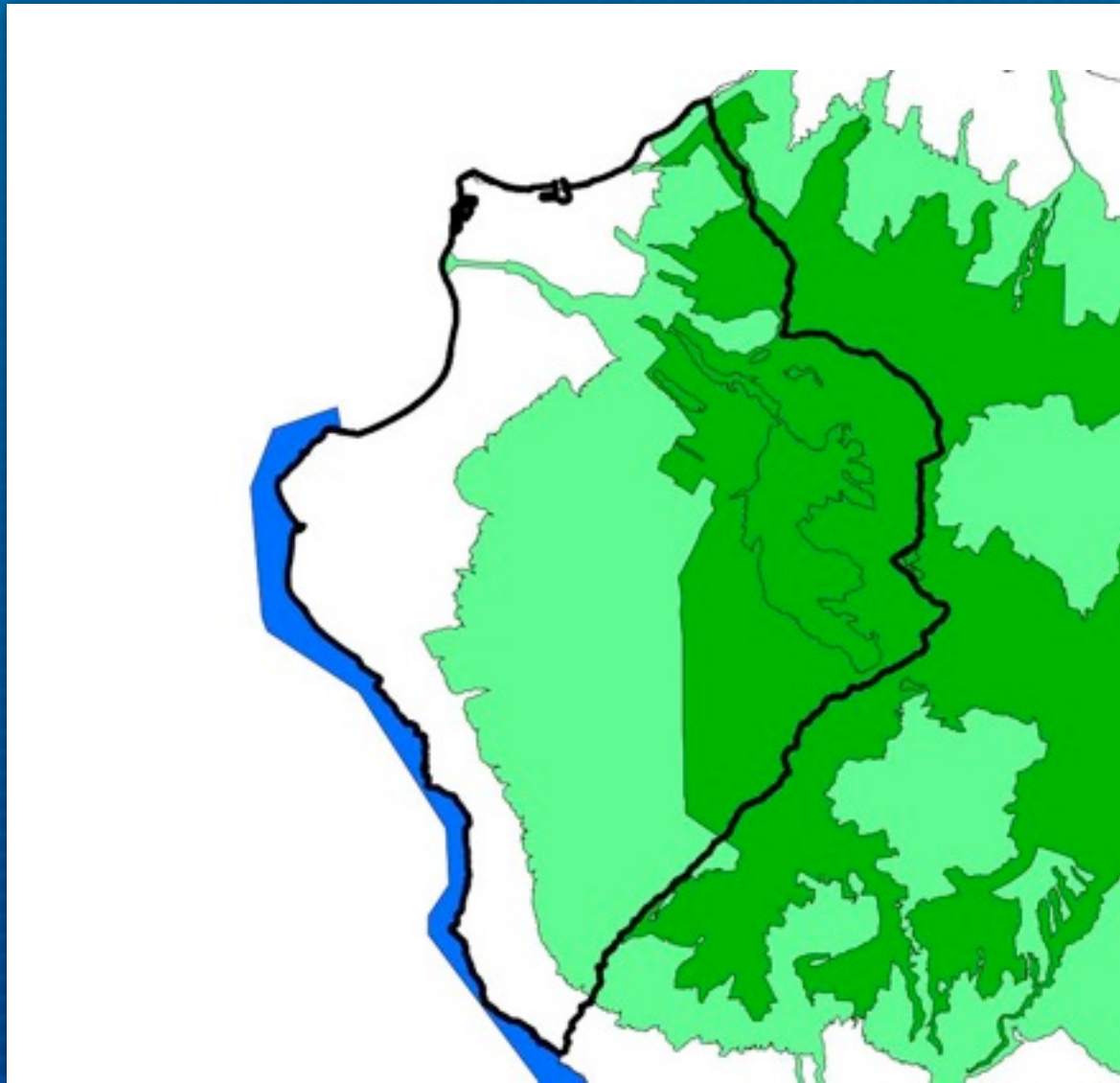


10 km





# Reunion Island - TCO territory



- ✦ Territoire de la Côte Ouest
- ✦ Inter-municipality
  - ✦ 5 municipalities
  - ✦ 14 towns
- ✦ 212,000 people
- ✦ 53,000 ha
- ✦ Sun, beaches!
- ✦ Trek & trail in Mafate!
- ✦ Tourism!



# TCO planners: co-construction of models, why?

- ✦ Apply landscape policy
  - ✦ Current land-use planning documents  
**Territorial Coherence Scheme** (SCoT)
- ✦ Prospective
  - ✦ On going land-use planning documents  
**Water Management Scheme** (SAGE)  
**Rural development Charter**
- ✦ Foster dialogue
  - ✦ Between **technical services** & **elected members**  
(models, visualization tools)
  - ✦ With **stakeholders**: sugar canne, livestock sectors  
(models, research project itself)

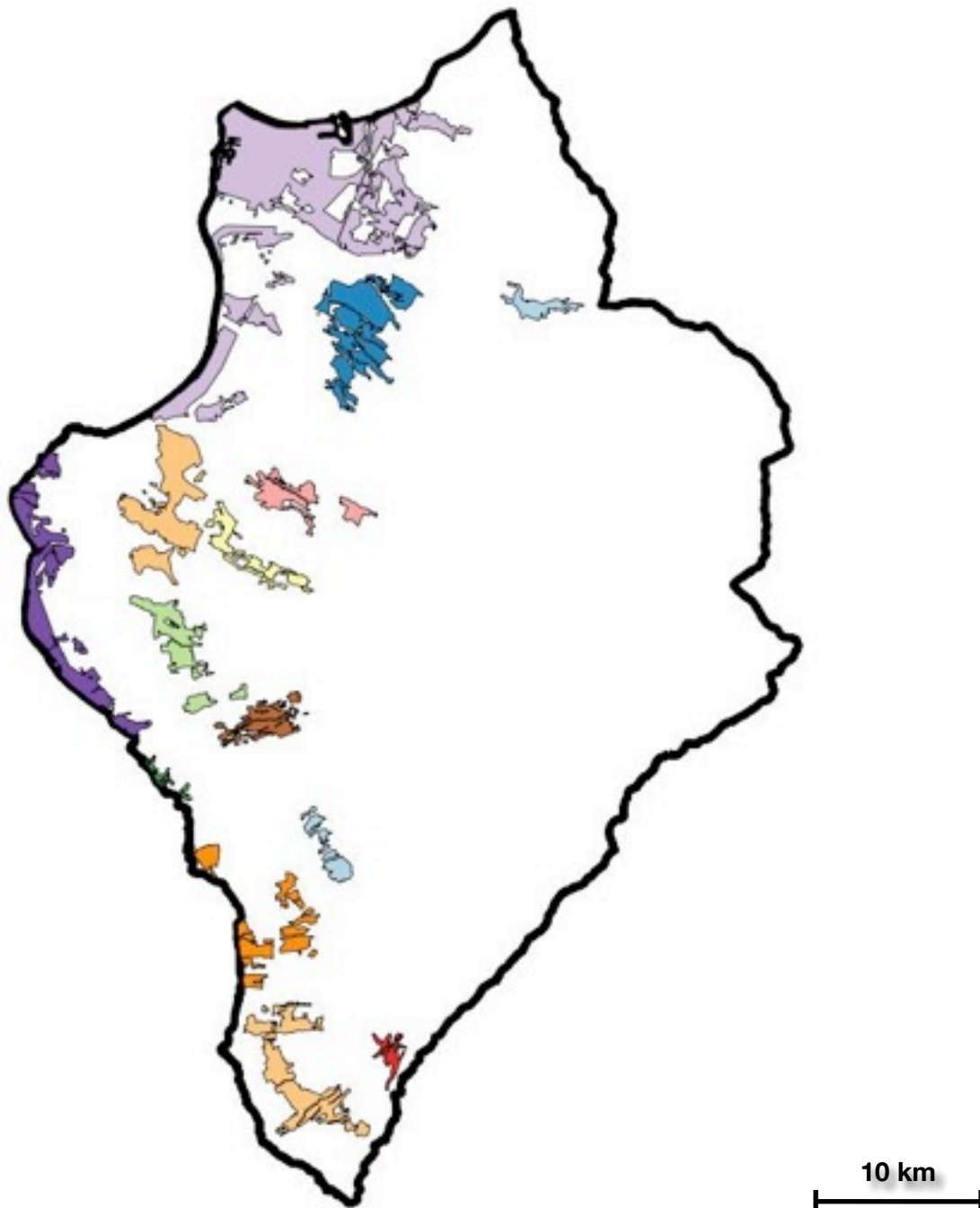


Our model

**Urban dynamics on that part of the island?**



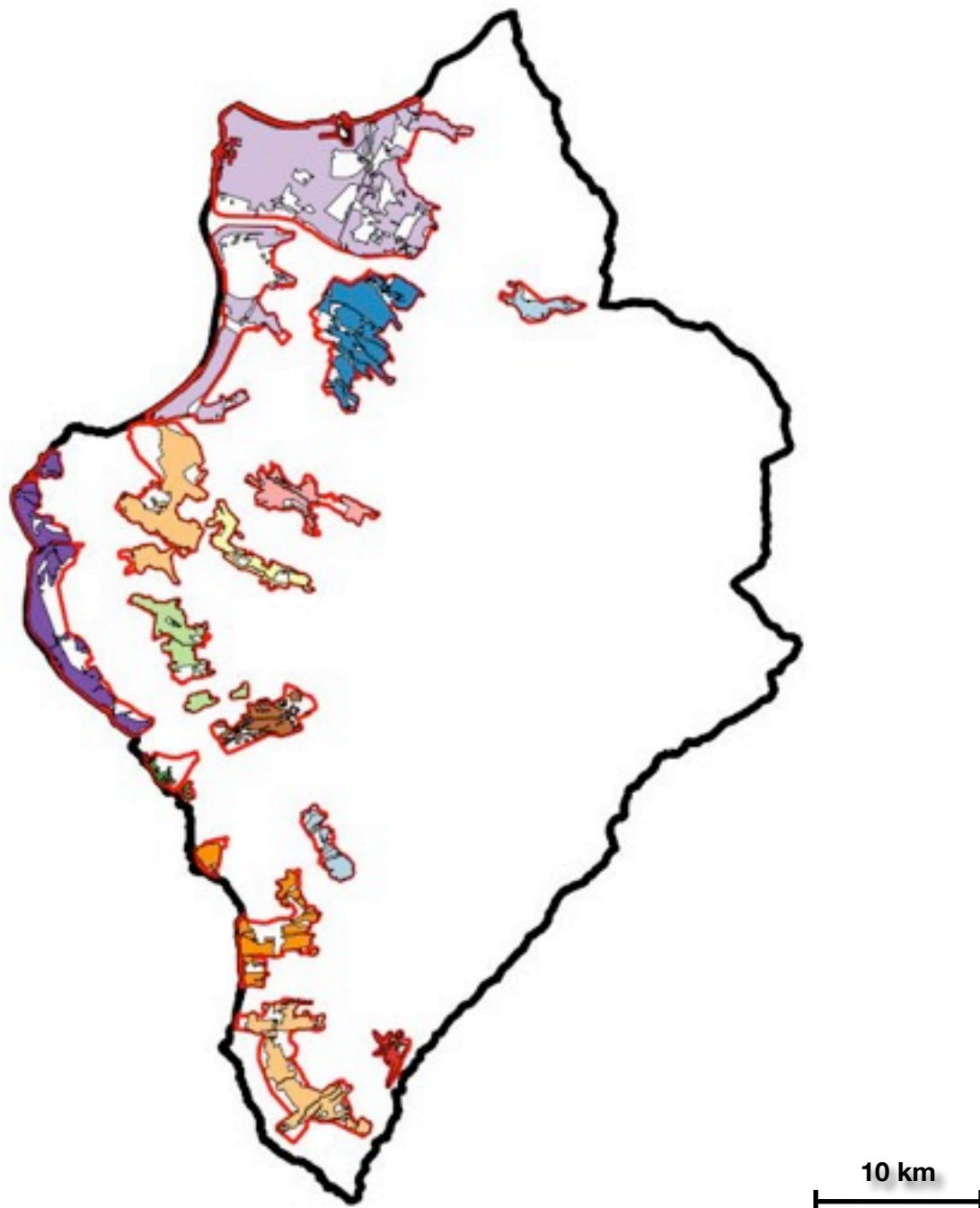
# Some data



- ✦ **GIS** data (shp)
  - ✦ Cities
  - ✦ Extension areas
  - ✦ Protection areas
  - ✦ Agricultural areas
  - ✦ Built areas
  - ✦ Cadastral **plots**
- ✦ Numeric data
  - ✦ **Densification** hypotheses
  - ✦ Housing demand
- ✦ Relationships data
  - ✦ Graphs



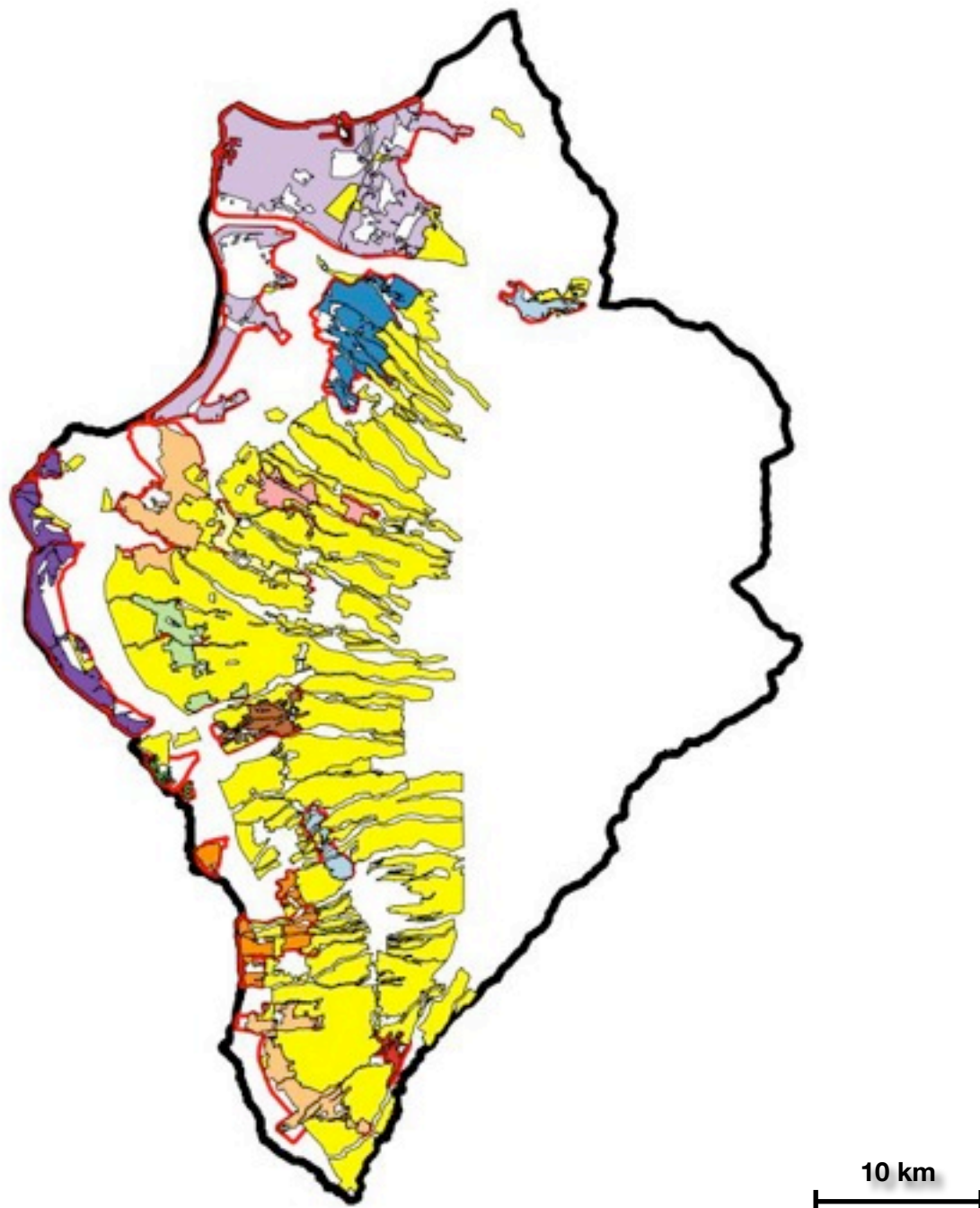
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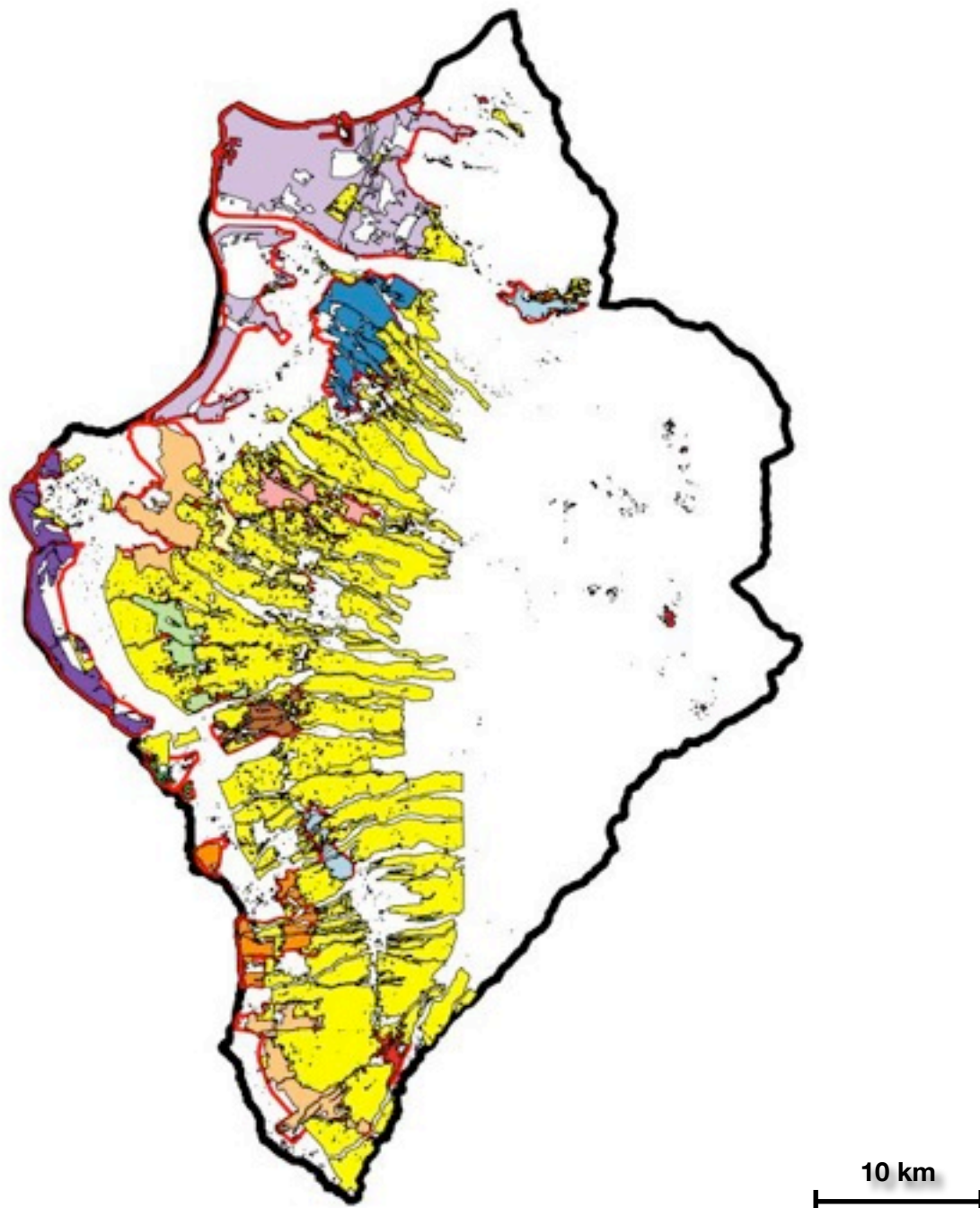
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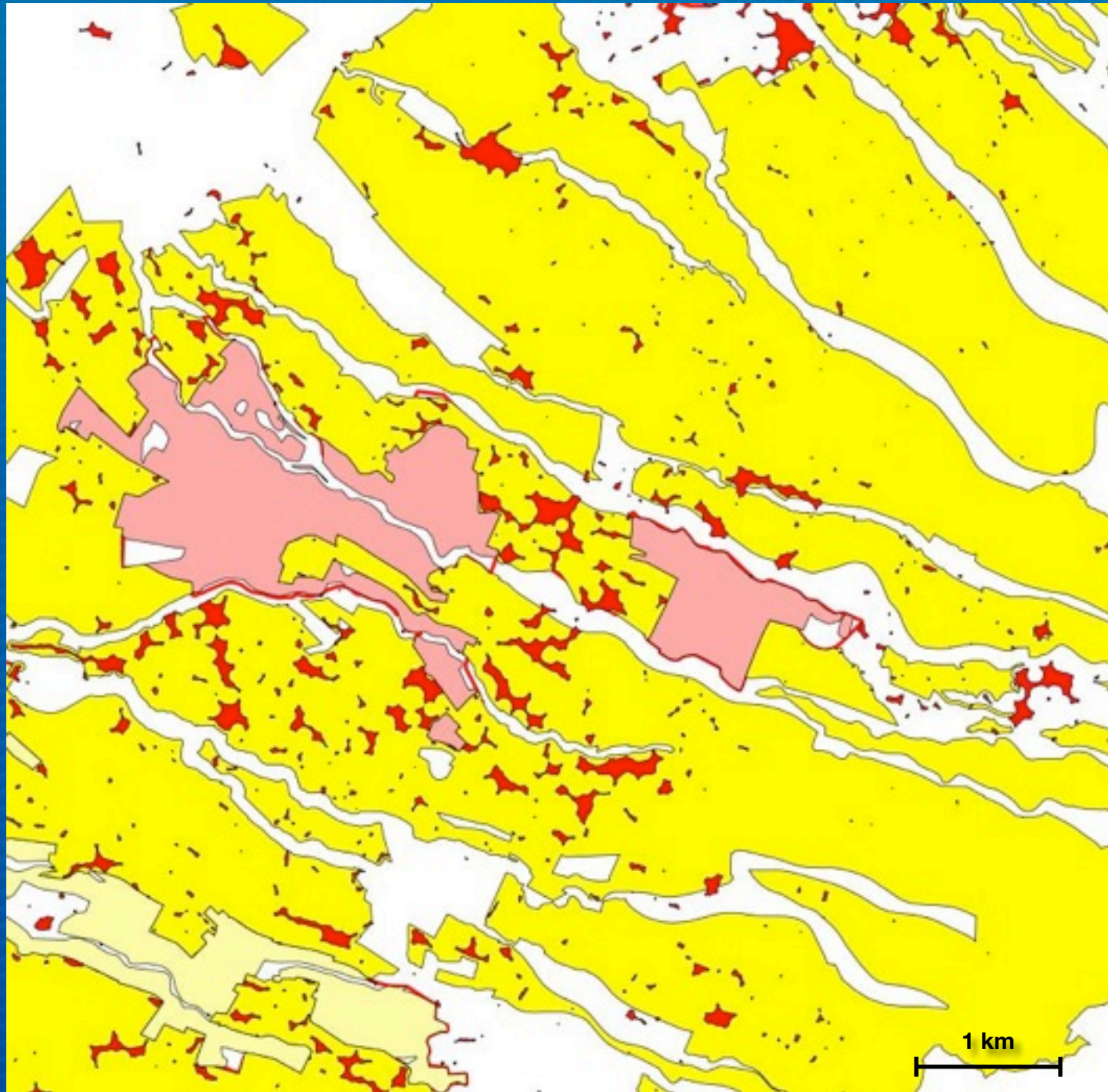
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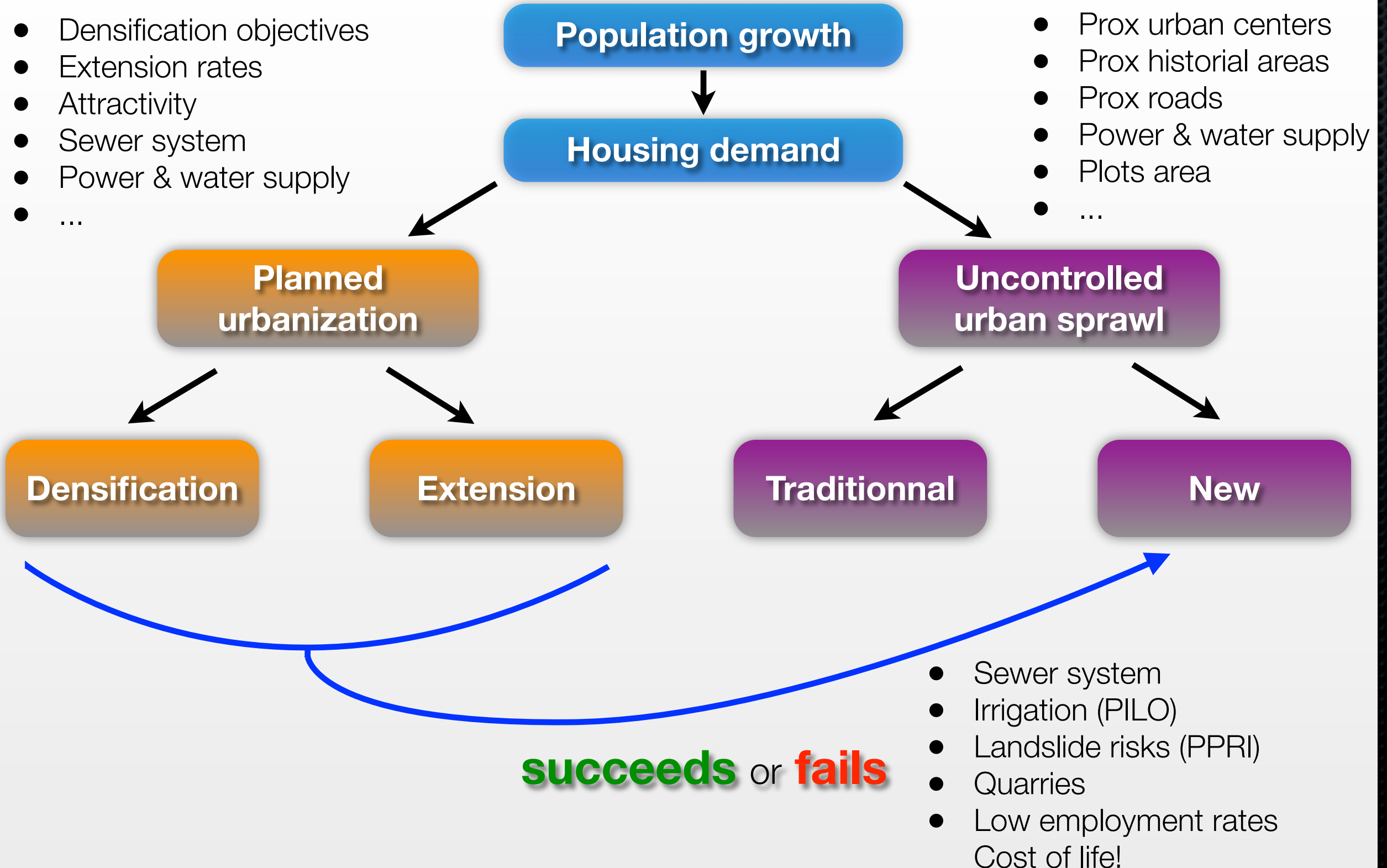
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  - ✦ Graphs



# Conceptual elements





# Implementation elements

- ✧ **Ocelet** Language - **O**celet **M**odelling **P**latform
- ✧ UMR **Tetis** - CIRAD Montpellier
- ✧ **D**omain **S**pecific **L**anguage (based on Java, xtext)
- ✧ **Entities** :
  - ✧ Spatial (Towns, Plots, Houses...)
  - ✧ Social (Institutions, Policy makers...)
- ✧ **Relationships** (belong to, govern, collaborate with...), Behavioral interaction **graphs**
- ✧ Simulation **scenarios**
- ✧ **GIS data** manipulation
  - ✧ **import** (loading data, creating Entities...)
  - ✧ **export** (shp, kml with temporal attributes...)

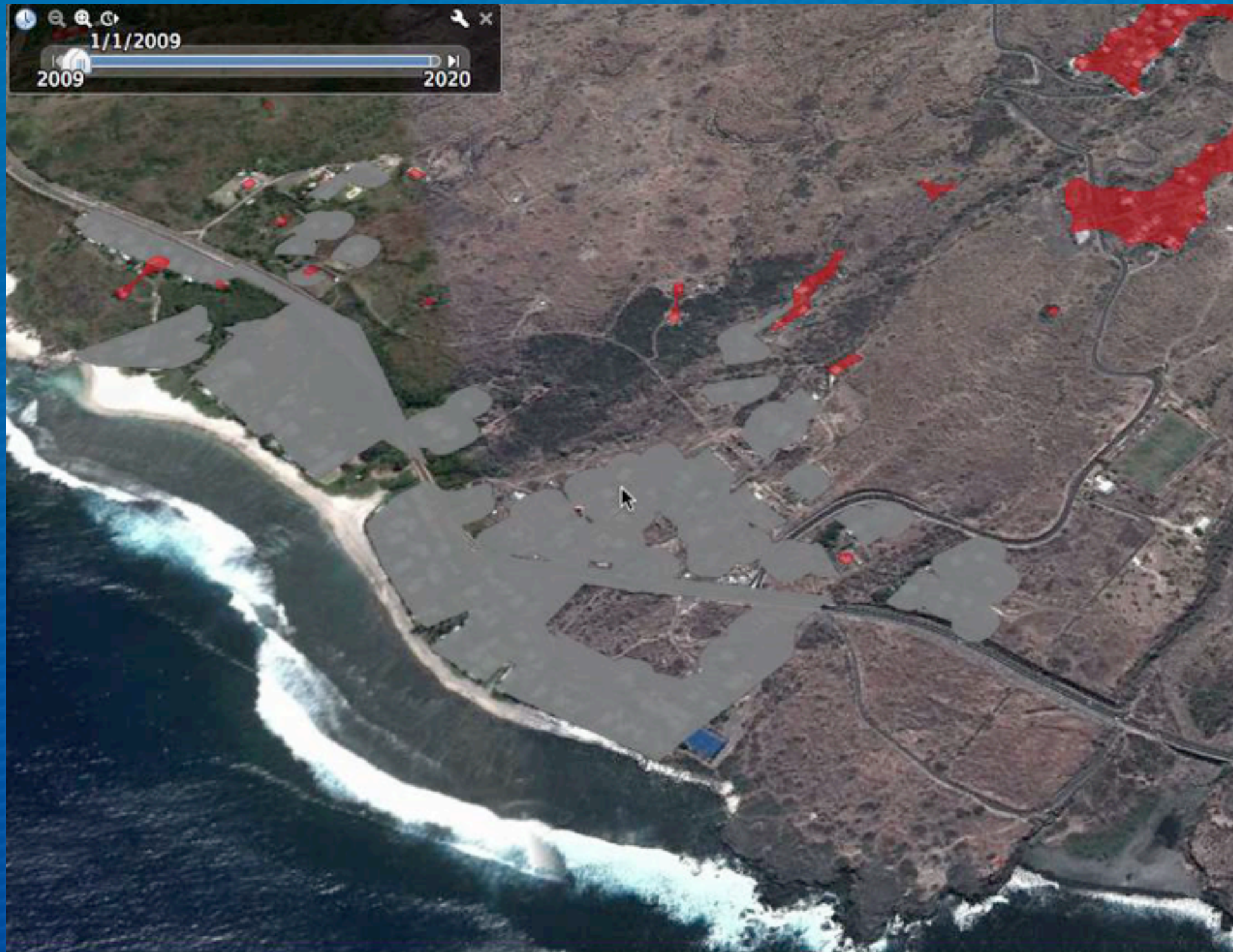


Outputs

**Planned urbanization**



# Planned urbanization - Coastal area





# Planned urbanization - Highlands



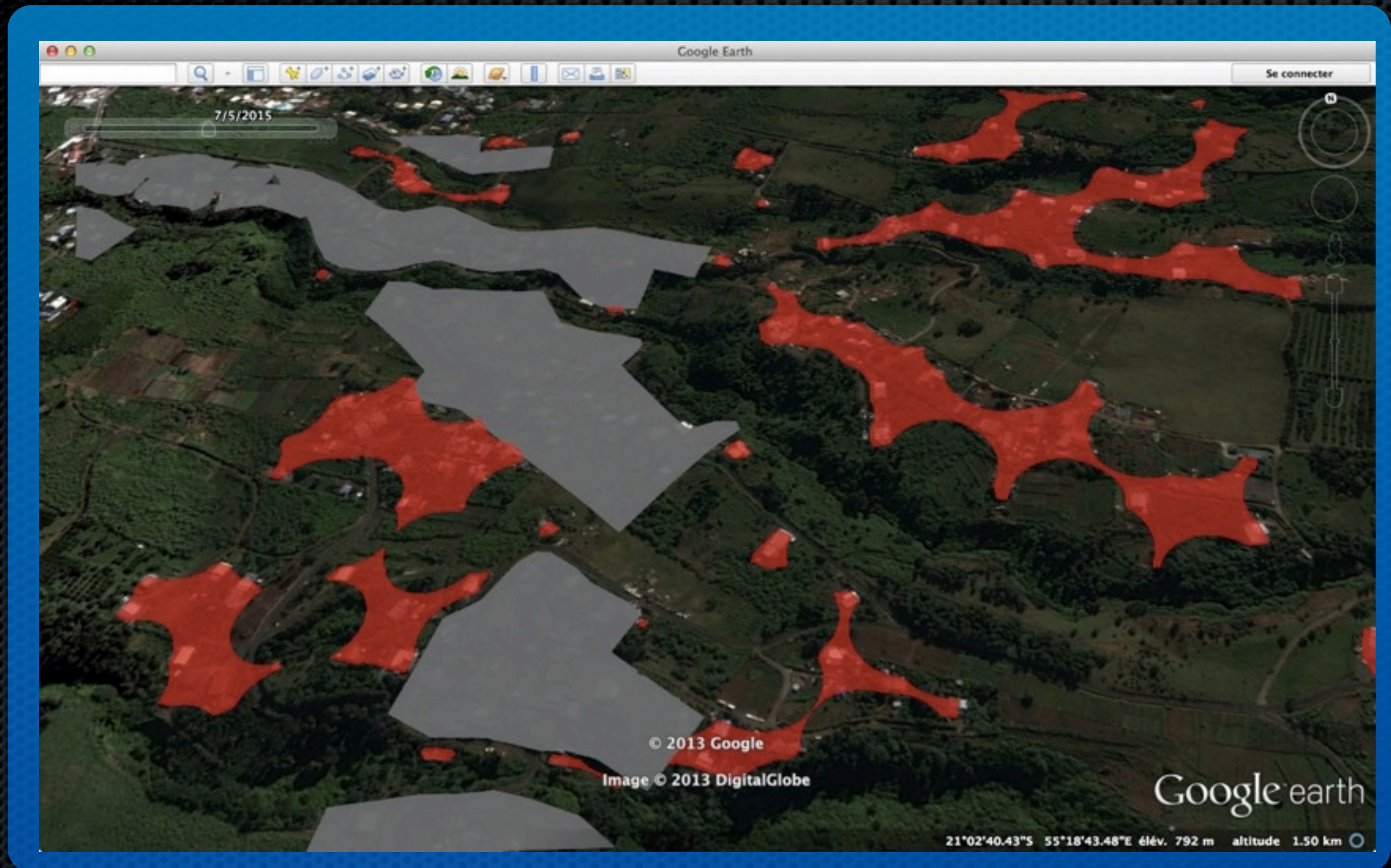


Outputs

**Uncontrolled urban sprawl**



# Uncontrolled urban sprawl



**Initial state**



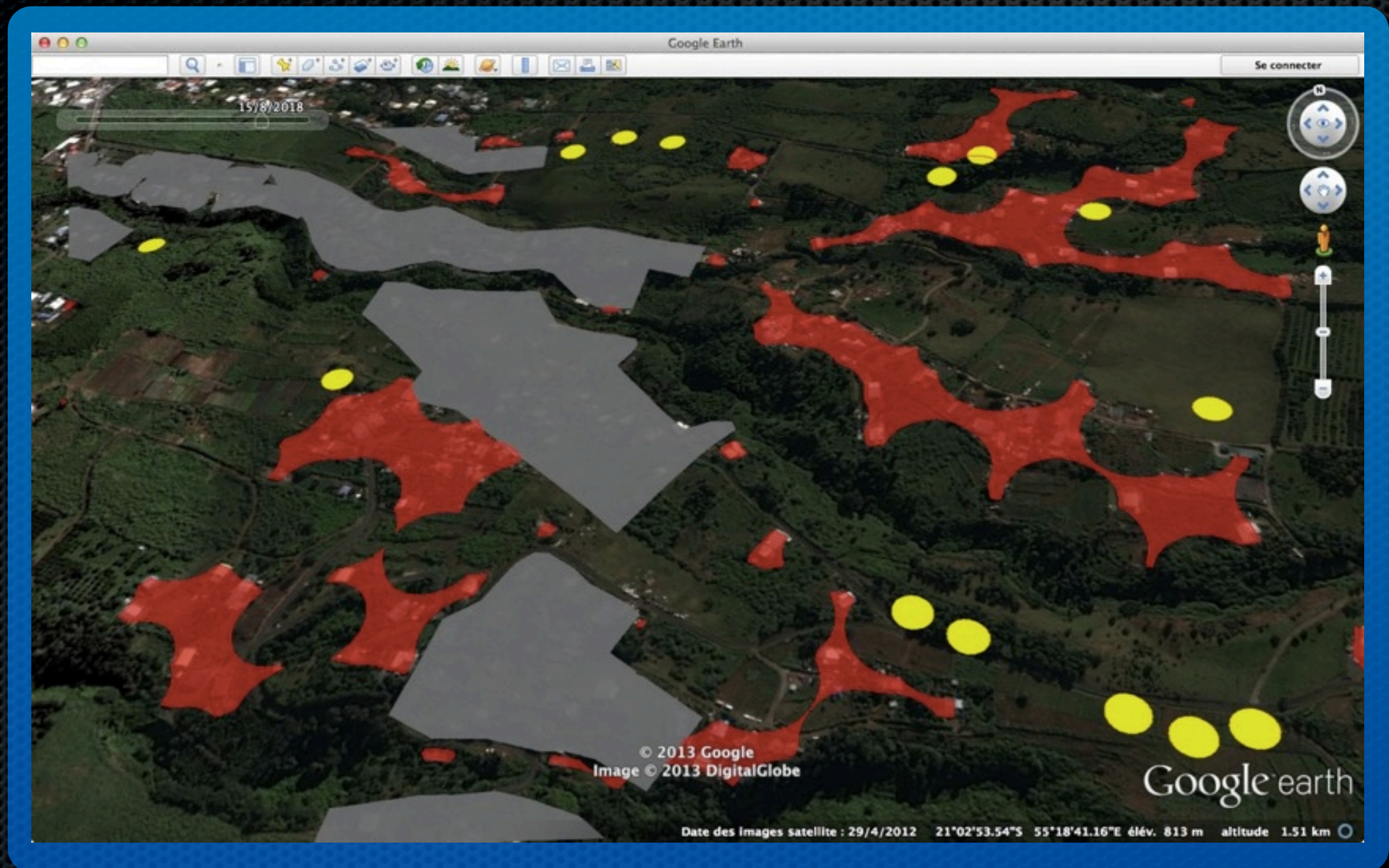
# Uncontrolled urban sprawl



**Final state - Traditionnal criteria**



# Uncontrolled urban sprawl



**Final state - New criteria - Networks proximity**



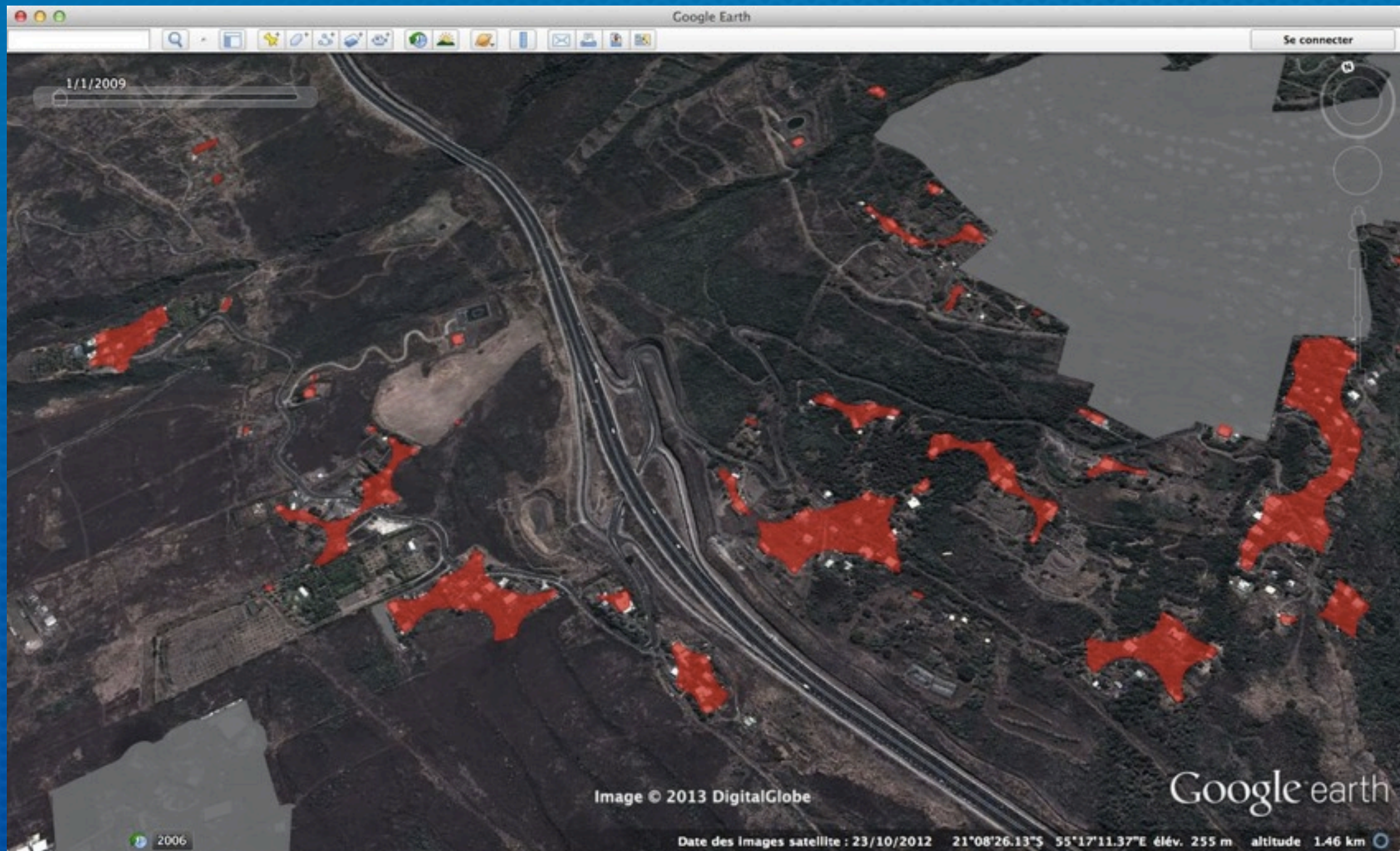
# Uncontrolled urban sprawl



**Final state - Mixed scenario**



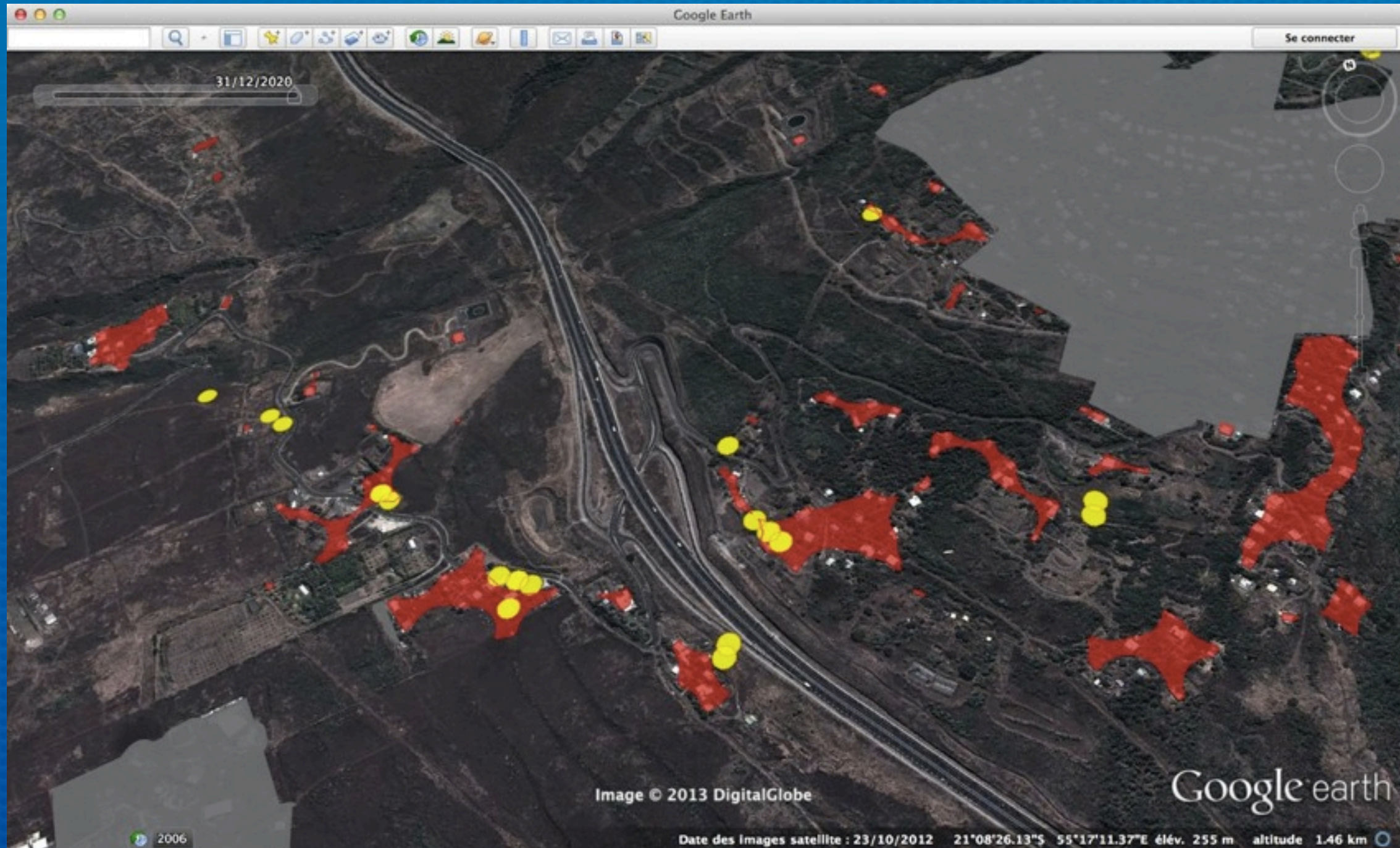
# Uncontrolled urban sprawl



**Initial state**



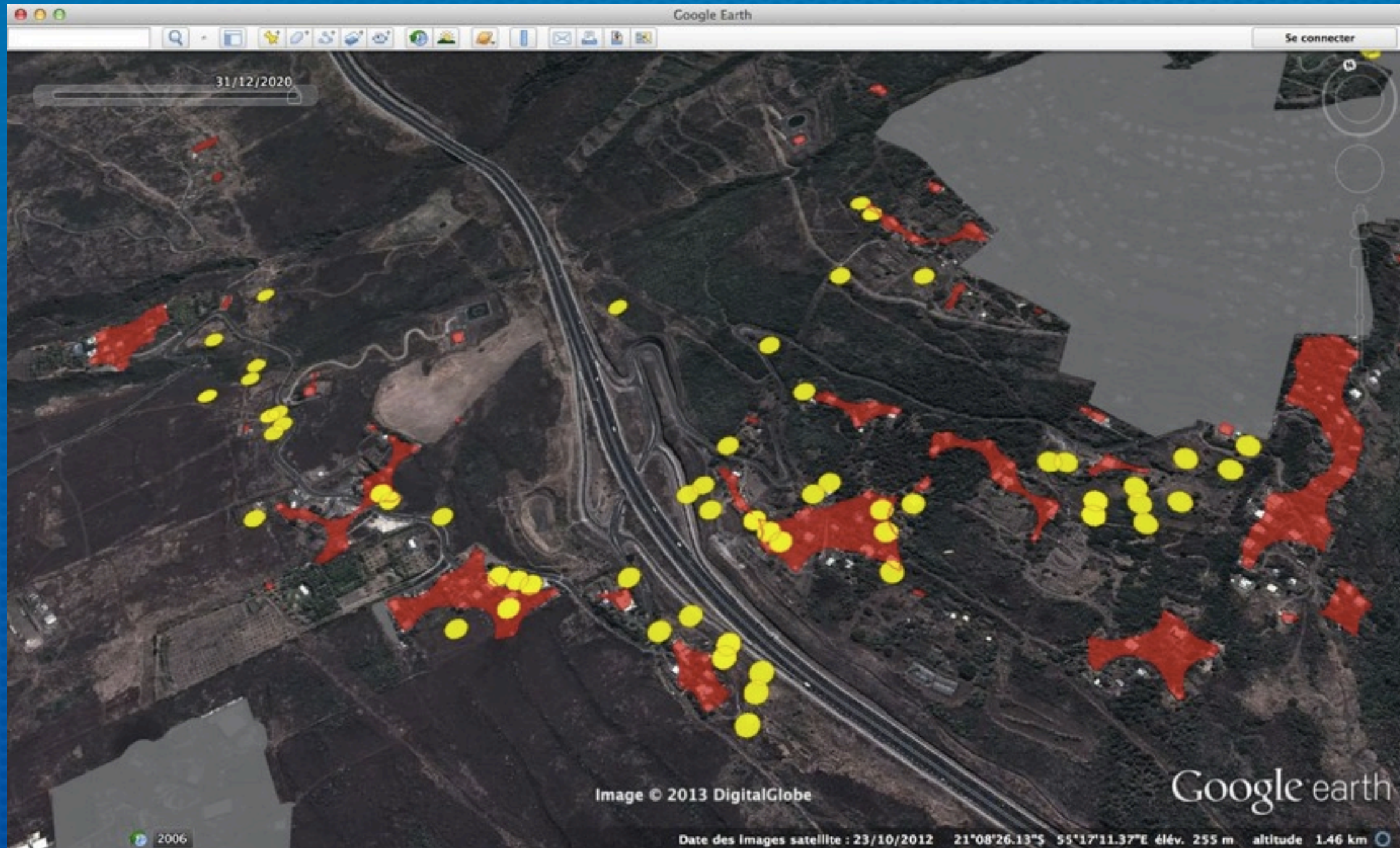
# Uncontrolled urban sprawl



**Final state**



# Uncontrolled urban sprawl



**Final state - With the influence of the interchange**

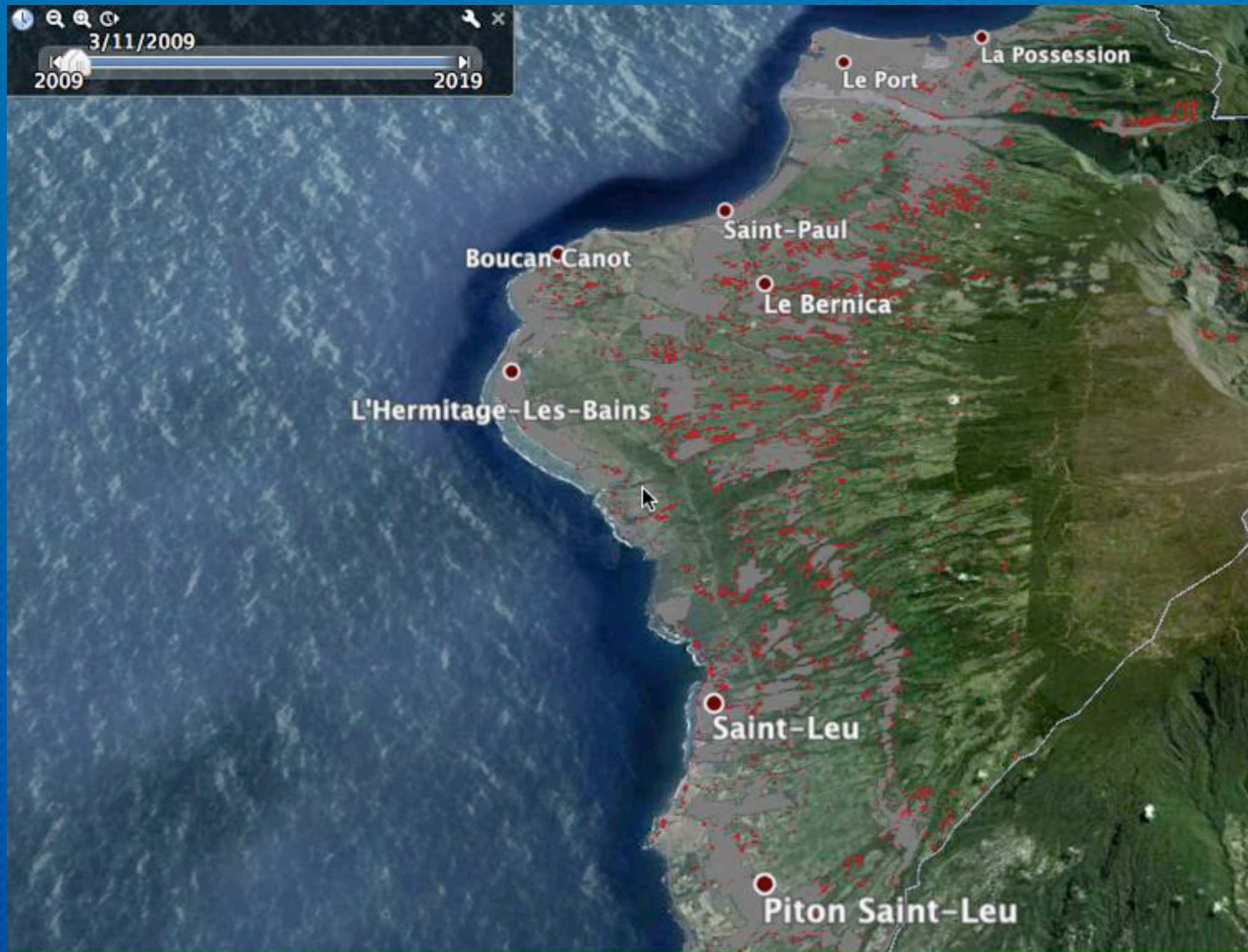


Outputs

**Complete model**

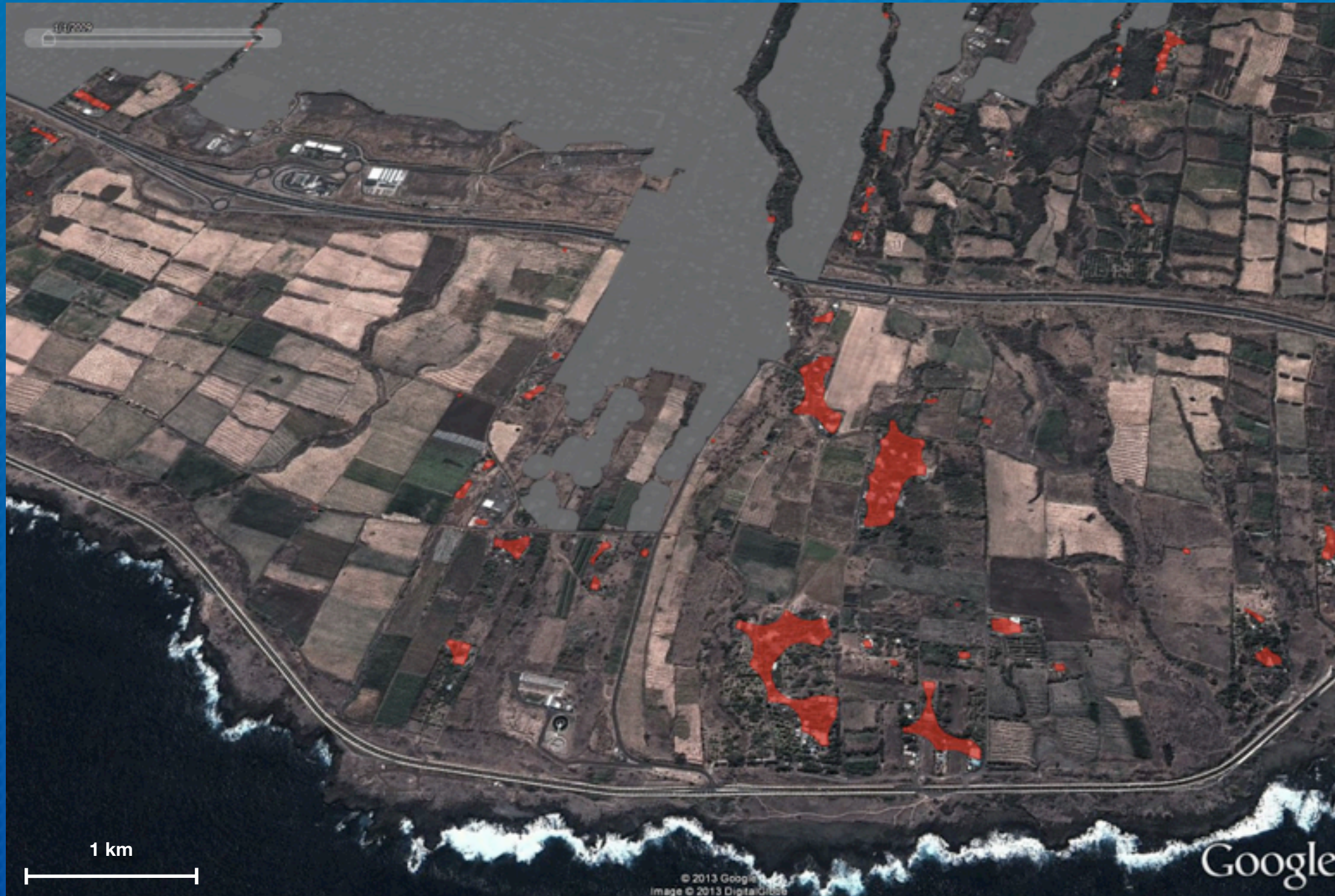


# On the TCO territory





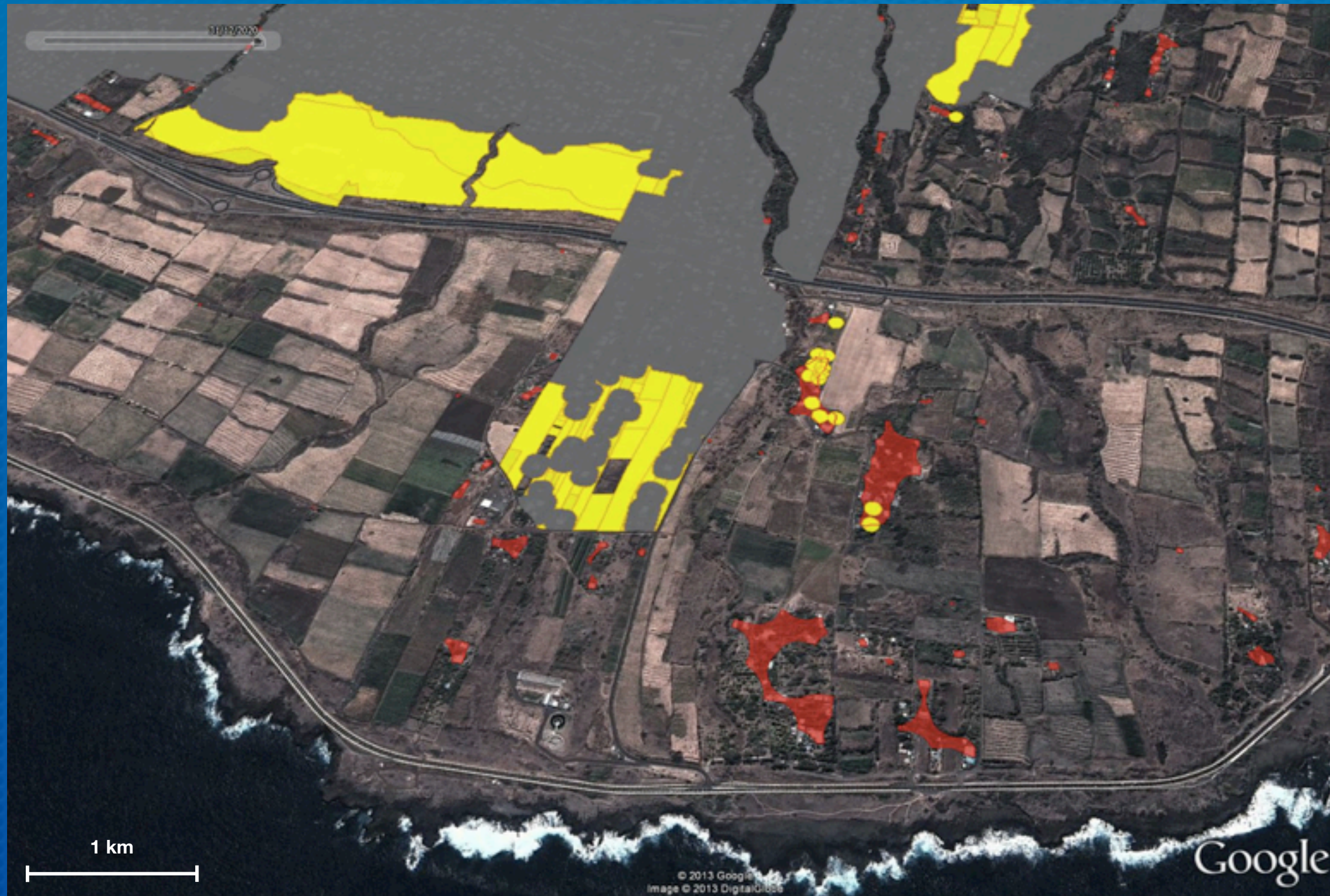
# Scenario Comparison



**Initial state**



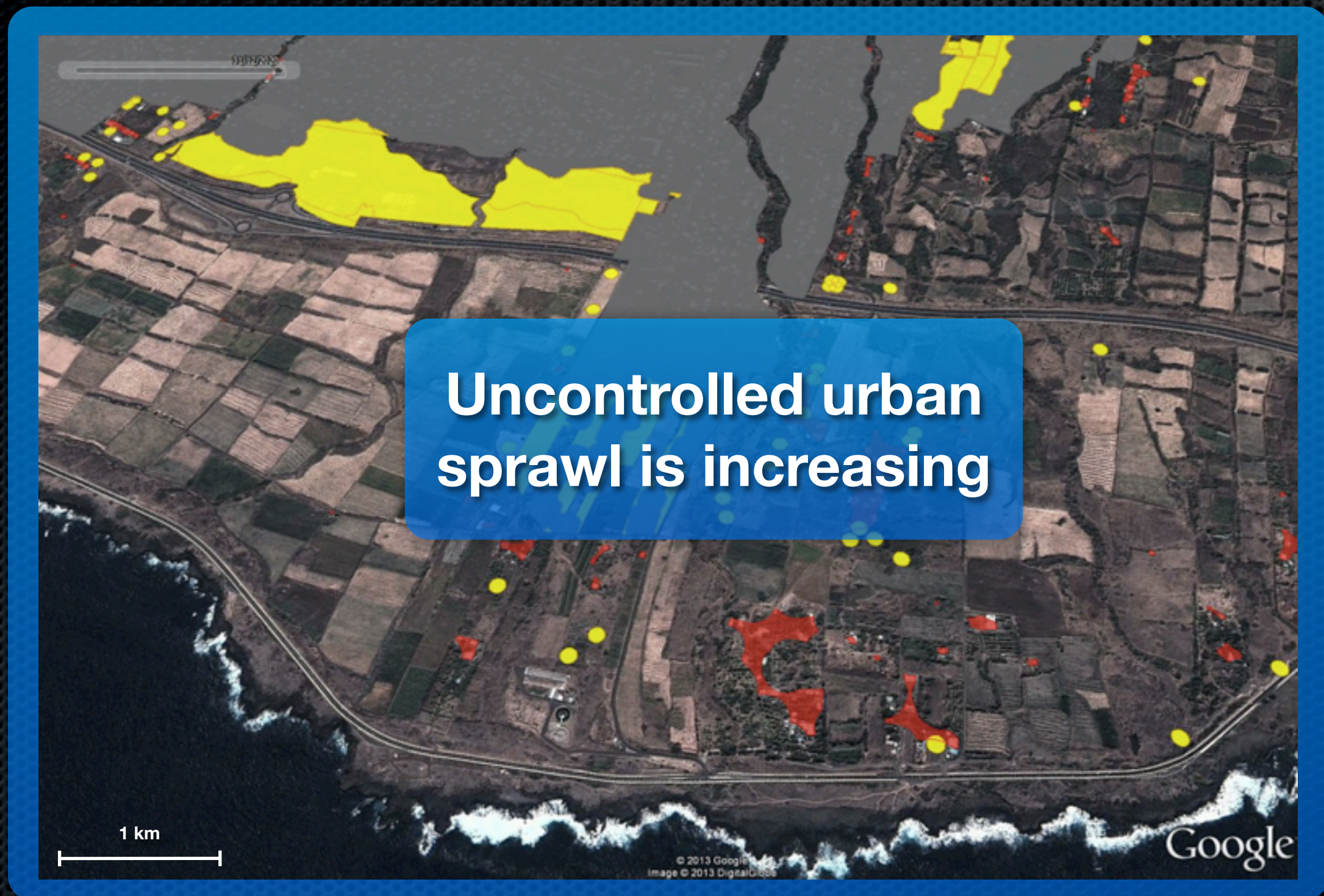
# Scenario Comparison



**Final state - High housing densification hypotheses**



# Scenario Comparison



**Final state - Low housing densification hypotheses**



To conclude  
**Briefly...**



# Few words about model usage

good?

- ✦ **Partnership** with **TCO** teams
- ✦ **Trust** relationship of their elected members
- ✦ Set up and **arena** of **30 stakeholders** on the TCO territory

bad?

- ✦ ...**difficult** to work with 30 stakeholders!
- ✦ Will of **exploitation** and **manipulation** by some **stakeholders**?



# What's next?

- ✦ Finish the **calibration** of the urbanization model:
  - ✦ **Social** housing
  - ✦ Availability of **funding** (State, Municipalities...)
  - ✦ **Exempt tax** laws (Girardin & Duflot laws)
- ✦ Finish the development of other models:
  - ✦ **Agricultural dynamics** (transitions)
  - ✦ **Pollution** of water ressource (phreatic tables)
  - ✦ Water **flows** (retro & prospective)
- ✦ Think about new models:
  - ✦ Diffusion of **exotic invasive species**
  - ✦ **Health geography** (leptospirosis, congenital malformations...)



# Questions?

## Infos:

[www.projet-descartes.fr](http://www.projet-descartes.fr)

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